Quarterly Report – Public Page

Date of Report: *October 14, 2010*

Contract Number: DTPH56-10-T-000002

Prepared for: *PHMSA-DOT, National Biodiesel Board, Steel tank Institute, DNV Research and Innovation*

Project Title: *Corrosion and Integrity Management of Biodiesel Pipelines*

Prepared by: *DNV Columbus*

Contact Information: *Joshua James t: 614-761-6934, e: Joshua.James@dnv.com*

For quarterly period ending: *September 30, 2010*

The second quarter has been devoted to finishing up portions of the literature review that were initiated after the PHMSA kickoff meeting in the truncated first quarter of work for the contract, *Corrosion and Integrity Management of Biodiesel Pipelines*. Based on completed portions of the literature review and meetings held with members of co-funding agency National Biodiesel Board many of the details of the testing under this project have been refined in quarter 2. Among these specifics that were left unresolved as of the close of the kickoff meeting were which inhibitors to test, which feedstocks of biodiesel to investigate and which elastomers were most applicable.

Based on discussions with a number of pipeline operators and literature on the subject it is recommended to include up to three of the most common corrosion inhibitors for diesel pipelines. The following products are suggested: Dupont AFA-1, Nalco EC 5407-A, and Tolad 3032. Inhibitor concentrations will be determined based on manufacturer's recommendations.

The literature review also revealed that differing levels of saturation can affect some biodiesel fuel properties significantly, even if the fuel meets ASTM D 6751. Subsequently, each feedstock is made of different proportions of saturated, monounsaturated, and polyunsaturated fatty acids. So the decision was made to test with three different feedstocks each representing a major benchmark in saturation level. Listed in increasing saturation levels, these are soy, animal fats and used cooking oil (yellow grease).

The literature review performed on the known interactions of polymers with biodiesel and petrodiesel revealed that Nitrile rubber compounds, polypropylene, polyvinyl, and Tygon® materials are particularly vulnerable to B100 exposure. Three candidate materials from these basic groups will be selected for testing.

The basic construction of test setups has also taken place and been completed in the second quarter. We have three main setups that coordinate with the three technical tasks involved in the proposed work:

Task 1 – Corrosion Inhibition Performance
Task 2 – Integrity of Non-Ferrous Metallic System Components (Cu-alloys)
Task 3 – Integrity of Non-Metallic System Components (Elastomers)

The test setups for Tasks 1 and 2 are congruous and consist basically of a daisy chain of temperature controlled glass vessels each containing a distinct experiment based on the proposed matrices. Task 3 utilizes a specialized block furnace for the testing of elastomeric materials. Each Task is discussed in further detail below.

Task 1 – Corrosion Inhibition Performance

Based on the literature review and discussions with a number of pipeline operators it is recommended to include up to three of the most common corrosion inhibitors for diesel pipelines. The following products are suggested: Dupont AFA-1, Nalco EC 5407-A, and Tolad 3032. Inhibitor concentrations will be determined based on manufacturer's recommendations.

As the title suggests, this task involves the verification of common petrodiesel inhibitors for efficacy in biodiesel. The inhibitors identified through the literature survey are I1, I2 and I3. These corrosion inhibitors will be studied in the four biodiesel blends (three distinct feedstocks) at two separate dosage levels.

The experimental setup is pictured in the following figure.

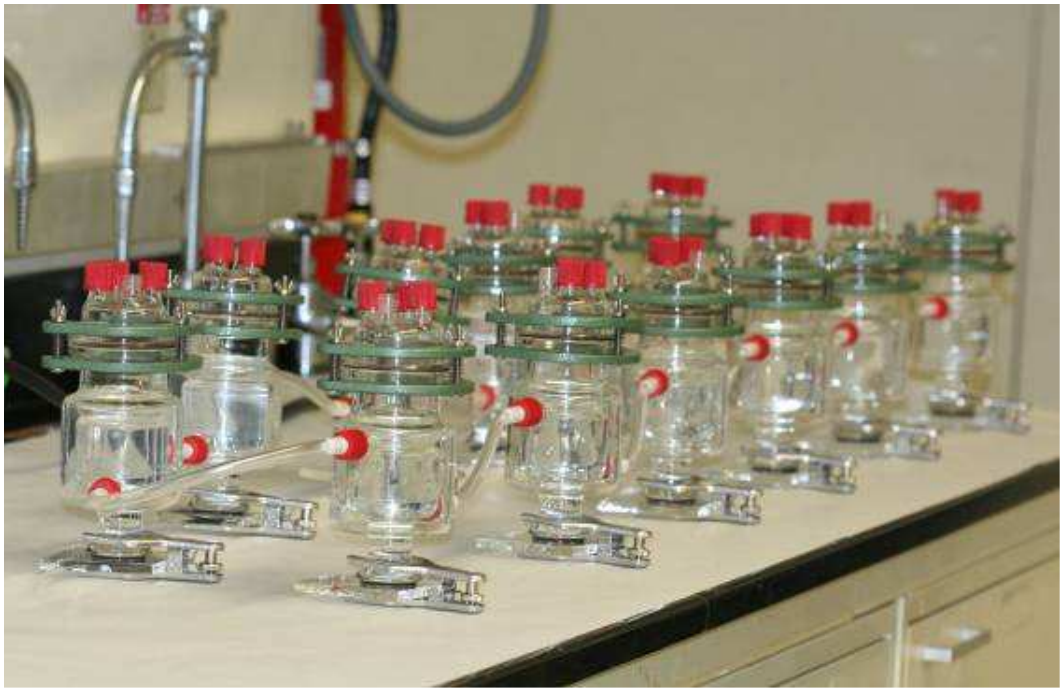

Figure 1. Array of test cells for inhibitors and Cu-alloys testing in biodiesel.

A close up of one of the glass cells in the area is pictured in the next figure.

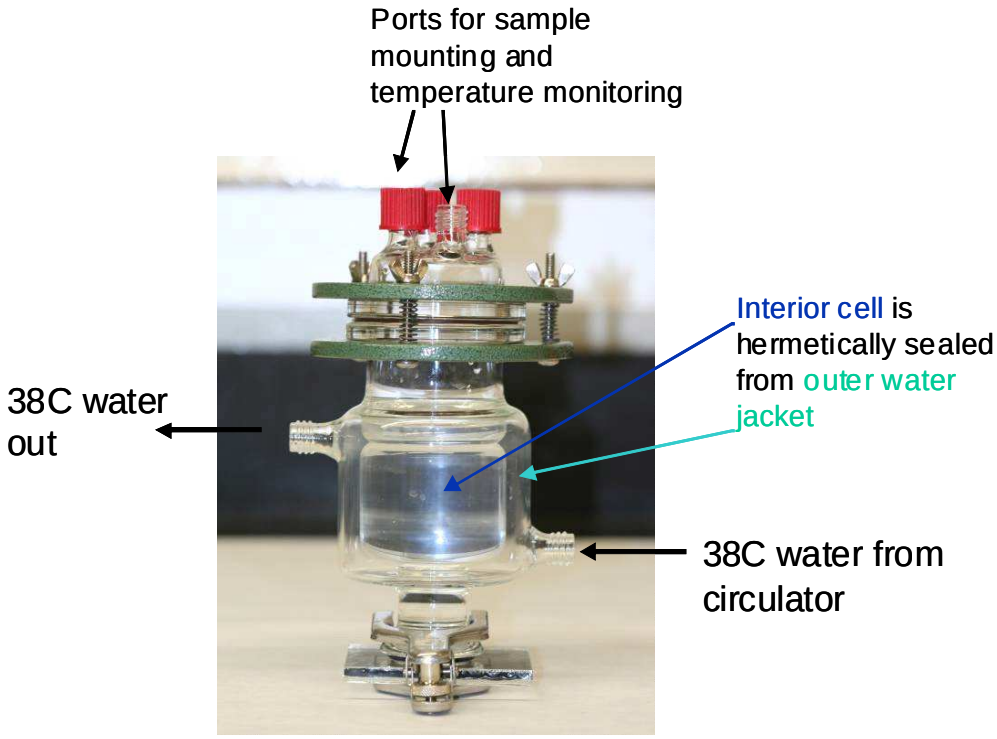

Figure 2. Example temperature controlled test cell to be used in immersion studies.

Each test cell will be daisy-chained to a circulating bath that will keep the immersions at 38 +/- 1ºC. Preliminary tests have been conducted to ensure that the temperature drop from the first cell connected to the bath to the last in the array is maintained within +/- 1ºC window. After a two hour period for equilibration of the system the temperature in cell 1 was 38.4 ºC and the final cell (cell 12) was reading a temperature 37 ºC. Fluctuation within the spread of cells was less than 0.5 ºC from one to the next. Twelve cells will be allocated to the inhibitors testing. A similar setup of eight additional cells will be utilized for the Cu-alloy and fuel degradation studies.

The second portion of inhibitors testing will begin in quarter 3 and will include sophisticated electrochemical measurement of the efficacy of the inhibitors via the use of micro-electrode array testing.

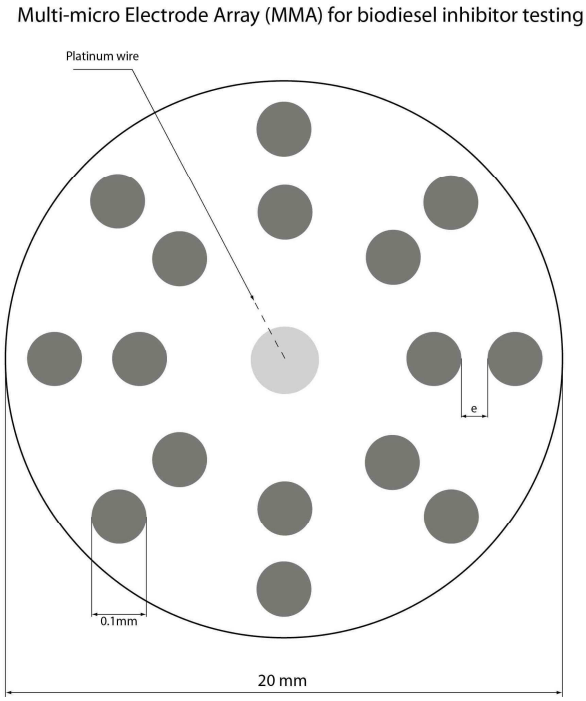

Figure 3. Schematic of the face of the multi-electrode array probe.

Task 2 – Integrity of Non-Ferrous Metallic System Components (Cu-alloys)

Task 2 has two main objectives. The first material-related objective is to document the degradation over time of Cu-containing alloys when immersed in the various blends and feedstocks of biodiesel. For this, one alloy will be utilized as a prudent example of common Cu-based alloys which experience regular incidence with the fuel. The second is to also monitor the oxidation of the fuel with respect to time of exposure to the alloy. Both experiments will take place in the same test cell. The type of cell pictured in Figure 2 allows for the insertion of counter and reference electrodes in order to monitor the corrosion behavior of the Cu-containing alloys electrochemically. Periodic samples of the fuel blend will also be collected to test for degradation of the biodiesel over the time period of the exposures. A series of eight additional test cells like pictured in Figure 1 will be allocated to electrochemical monitoring of the Cu-alloy corrosion behavior using a multiplexed potentiostat. These will also be temperature controlled using a circulating bath at 38 +/- 1ºC.

Task 3 – Integrity of Non-Metallic System Components (Elastomers)

For the testing of elastomer materials, a 28 test tube block furnace is used. Each test tube will hold contain one specific experiment in the matrix. The objective is to discern the tendency of specific elastomeric materials to swell, experience increased brittleness and have a reduction in compression strength as a result of prolonged exposure to the matrix of biodiesel blends.

Unfortunately, the start of testing is suspended pending the arrival of biodiesel samples from one of our co-funding organizations. Many efforts have been made to arrange the acquisition of samples of each of the three aforementioned feedstocks along with enough

petrodiesel to make each of the blends to yet no avail. With the acquisition of fuel samples, test setup for all technical tasks can be completed. Preliminary testing of the micro-electrode evaluation technique for Task 2 may also begin. Actual data collection is planned to commence in quarter 3 again pending the acquisition of adequate amounts of biodiesel and petrodiesel fuel samples.